

Frontal Plow for Tillage of Sloping Fields under Uzbek Conditions

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ABSTRACT

The necessity of development of anti-erosion moisture-saving technical means of tillage in the conditions of Uzbekistan is shown. The devices and principle of work of frontal plough for tillage of sloping fields, and also results of its tests in economic conditions are resulted. It is established, that development and introduction of the frontal plough contributing to soil protection from water erosion and improvement of moisture accumulation in the root-inhabited soil layer is promising.

KEYWORDS: water erosion, soil, moisture conservation, technology, frontal plow, slope

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1. INTRODUCTION

The peculiarity of the climate in the southern region of Uzbekistan is a low amount of precipitation. Deficit of productive moisture is caused not only by shortage of precipitation, but also by irrational use of rainfall. Soil moisture deficit and unstable moisture pattern restrain the growth of agricultural production, especially in rainfed agriculture [1-7].

The existing system of machinery for crop production in Uzbekistan, created mainly for irrigated agriculture, does not meet the requirements of the most complete accumulation and conservation of soil moisture. As a result, more than 70% of the sown area in Uzbekistan is exposed to water erosion to a greater or lesser degree. Water erosion is strongly manifested on sloping areas, especially during heavy rains [6-12].

It is known that in the system of agro technical methods the main moisture-saving role is given to the methods of soil treatment, which should provide the most complete accumulation of moisture of atmospheric precipitation in the root layer and prevent its evaporation through the cultivated soil layer. Therefore, it is necessary to apply special anti-erosion technologies and technical means of soil treatment to prevent water runoff and soil washing out [10-15].

The aim of the work is to develop a frontal plough contributing to moisture conservation and prevention of water erosion on sloping lands.

Objects and methods of research. Objects of researches are technology of smooth plowing of slope fields and frontal

plough for its realization. When determining qualitative indicators of plough operation, we were guided by the program and technique of testing agricultural machines according to OST 104.2-89.

2. Results and Discussion

The authors developed a special frontal plough for tillage soil slopes [7], which contains the left 1 and right 2 sections, which are mounted on a frame 3 ripper 4, disc knives 5, right-blowing housing 6 and 8 left section 1 and left-blowing housing 7 and 9 right section 2. On the bodies set skimmers 10 and 11 with their working surfaces facing the plough bodies and ploughs 12 and 13 with inclined racks 14. The posts 14 of the ploughs are inclined toward the symmetry axis of the plough. The length L1 of skimmers 10 adjacent right - and left-swiveling bodies 6 and 7 of the right and left sections is less than the length L skimmers 11 other bodies 8 and 9 at 0.25L. Left 1 and right 2 sections are shifted relative to each other in the transverse plane by the value bc. Ripper 4 is installed along symmetry axis in front of adjacent bodies, working width bp of which is equal to width bc of sections displacement. The height h of ripper 4 is less than the height H of the bodies.

When the right and left sections shift in transverse direction relative to each other during plough operation, an uncultivated strip is formed at the bottom of the furrow of the arable layer, which contributes to retention and accumulation of rain water. Installing the ripper in front of the bodies and making its width equal to the width of displacement of the bodies of the right and left sections

eliminates the formation of uncultivated strip on the top layer of soil. In addition, the ripper performs surface loosening, which consumes less energy than the turnover of layers of this strip. The height of the ripper is less than the height of the bodies, and this contributes to the formation of a stepped furrow bottom in the arable layer and, accordingly, the retention and accumulation of rainwater.

When performing the length of the skimmer adjacent bodies, ie, each first body of the right and left sections, than the length L skimmer other bodies by $0,25L$ they carry out an incomplete turn of the layers, ie on 135° towards each other. This results in the formation of ridges on the surface of the arable land, which contribute to the retention and accumulation of rainwater, which prevents the occurrence of water erosion. In this case the incomplete rotation of the layer consumes much less energy than a full turn by 180° .

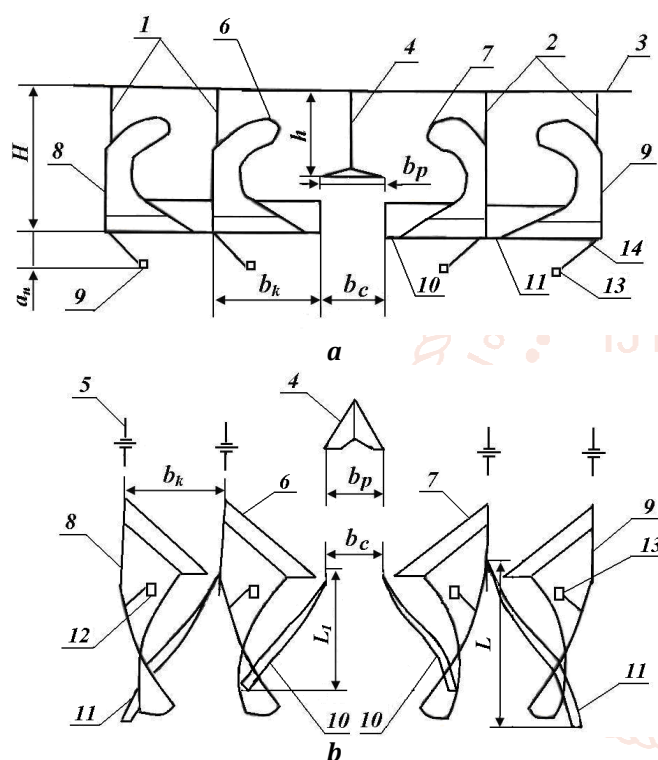


Fig.1. Diagram of frontal plough for slope treatment: a - rear view; b - top view

Installation of plough bodies behind each plough body promotes formation of stepped furrow bottom in subsoil layer and accordingly retention and accumulation of rain water. Due to the tilt of the tines towards the symmetry axis of the plough, it is possible to attach them to the plough body post and symmetrically position them on the plough frame.

All this allows to reduce traction resistance of the plough, improve tillage quality and prevent water erosion on sloping fields. The plough works in the following way. Ploughing is carried out across the slope. While ploughing soil across the slope, ripper 4 loosens a strip of width b_r to the depth A , disc blades 5 cutting soil in vertical plane separate cultivated soil layers from the rest massif, Then the adjacent right- and left-hand-turning bodies 6 and 7 the left 1 and right sections with a height H and a width of capture b_k penetrating into the soil are separated from the soil layers $ABCD$ and $A_1BC_1D_1$ with a thickness a from the bottom of the furrow on the right and left side of loosened band and interaction with short skimmers 10 turns them to 135° towards each

other and place on the loosened ripper 4 band. As a result, a ridge is formed over the loosened strip ripper 4. The subsequent bodies 8 and 9 of the left 1 and right 2 of the interaction section with long skimmers 11 are cutting, turning and stacking layers $EFGH$ and $E_1F_1M_1N_1$ by 180° in their own furrow. At the same time with the turnover of layers by the bodies the ploughs 12 and 13 perform subsoil loosening to the depth of a_p .

After ploughing, a stepped furrow bottom and ridged tillage surface are obtained. The combination of stepped furrow bottoms and ridged plough surfaces promotes water retention and eliminates soil washout after heavy precipitation. All this contributes to reduction of traction resistance of the plough, improvement of tillage quality and prevention of water erosion on sloping fields.

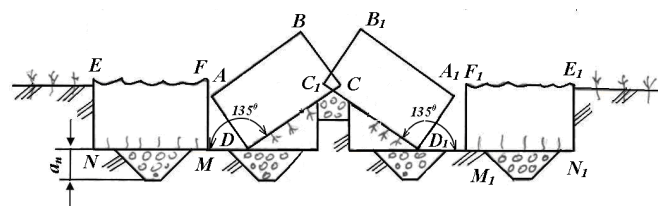


Fig.2. Scheme of layer turnover by front plough

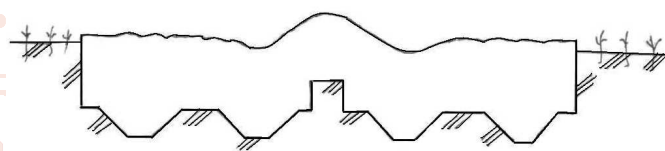


Fig.3. Cross-sectional profile of the field after ploughing

PFS-4 plough with 45 cm wide bodies and 15 cm wide ripper was made. Tests showed that technological process is carried out by plough steadily and reliably. At operation of plough, steps with width 30 cm and depth 12 cm are formed at the bottom of furrow, and ridges with height 12.8 cm are formed at the surface of arable land. At the same time, the depth of ploughing was 23.4 cm. Combination of stepped bottom of furrow with ridging of arable surface promotes water retention and elimination of soil washing off after storm rainfalls, i.e. water erosion. In addition, the front plough operates in shuttle mode of motion without pile ridges and breakage furrows, which contributes to a significant increase in the quality of plowing and labor productivity.

3. Conclusions

It has been established that development and introduction of a frontal plough contributing to soil protection from water erosion and improvement of moisture accumulation in the root-inhabited soil layer is promising.

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